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ABSTRACT

Established by Congressional Act in 1950, the National Science Foundation (NSF) is charged with a variety of responsibilities in the areas of education, research, applications of research, data gathering, and information dissemination. The foundation is governed by an appointed director and a national board and is primarily funded by the federal government. Spending approximately 10 percent of the nation's funds for research and development, the NSF sponsors research which promises substantial benefits for society in the future. Proposals are submitted to an open competition, and winners are selected by a panel of experts. Since computers permeate most fields of science, the NSF also provides computer technology and time-sharing for subsidized researchers. Also, it is presently sponsoring an overview study of the state of computer art in the United States. Other studies on computers and privacy and on the role of computers in educational innovation will be forthcoming. (EMH)

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NATIONAL SCIENCE FOUNDATION PROGRAMS

Kent K. Curtis

THE NATIONAL SCIENCE FOUNDATION WAS ESTABLISHED BY ACT OF CONGRESS IN 1950. ACCORDING TO THE ACT, THE FOUNDATION'S PURPOSE IS, "TO PROMOTE THE PROGRESS OF SCIENCE; TO ADVANCE THE NATIONAL HEALTH, PROSPERITY, AND WELFARE; TO SECURE THE NATIONAL DEFENSE; AND FOR OTHER PURPOSES." I HOPE AND BELIEVE OUR WORK IS CONTRIBUTING TO ALL OF THOSE GOALS.

THE FOUNDATION'S PRINCIPAL FUNCTIONS ARE TO: INITIATE AND SUPPORT BASIC SCIENTIFIC RESEARCH; INITIATE AND SUPPORT PROGRAMS TO STRENGTHEN SCIENTIFIC RESEARCH POTENTIAL; APPRAISE THE IMPACT OF RESEARCH UPON INDUSTRIAL DEVELOPMENT AND THE GENERAL WELFARE; AWARD FELLOWSHIPS IN THE SCIENCES; INITIATE AND SUPPORT SPECIFIC INTERNATIONAL SCIENCE ACTIVITIES; AND RECOMMEND AND ENCOURAGE THE PURSUIT OF NATIONAL POLICIES FOR THE PROMOTION OF BASIC RESEARCH AND EDUCATION IN THE SCIENCES. THERE ARE ADDITIONAL MORE SPECIFIC FUNCTIONS INCLUDING A VARIETY OF DATA GATHERING AND REPROTING ACTIVITIES WHICH PROVIDE INFORMATION ON SCIENCE RESEARCH, SCIENCE EDUCATION AND MANPOWER. FINALLY, IN RESPONSE TO CRITICAL NATIONAL PROBLEMS, THE FOUNDATION HAS BEEN ORGANIZING PROGRAMS OF APPLIED RESEARCH DURING THE LAST FEW YEARS TO USE THE RESULTS OF BASIC RESEARCH FOR SHORTER RANGE, HIGH PRIORITY NATIONAL GOALS. IN BASIC RESEARCH AND SCIENCE EDUCATION PROGRAMS, THE NSF DEALS PRIMARILY WITH EDUCATIONAL INSTITUTIONS AND NON-PROFIT ORGANIZATION. IN APPLIED RESEARCH IT DEALS WITH ALL SECTORS OF THE NATION INCLUDING FOR-PROFIT ORGANIZATIONS AND STATE AND LOCAL GOVERNMENTS.

POLICY FOR THE FOUNDATION IS SET BY THE DIRECTOR AND THE NATIONAL SCIENCE BOARD, APPOINTED BY THE PRESIDENT FOR THAT PURPOSE AND ALSO TO ADVISE HIM ON NATIONAL SCIENCE POLICY. THIS BOARD INCLUDES SCIENTISTS FROM ALL AREAS OF THE COUNTRY REPRESENTING A BROAD SPRECTUM OF PROFESSIONAL.

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AND BUSINESS INTERESTS. THE DIRECTOR AND THE MEMBERS OF THE BOARD HAVE SIX YEAR TERMS OF OFFICE, THE TERMS OF BOARD MEMBERS BEING STAGGERED SO THAT ONE THIRD OF THEM EXPIRE EVERY TWO YEARS. IN ADDITION, FIVE OTHER OFFICERS OF THE FOUNDATION ARE PRESIDENTIAL APPOINTEES, THE DEPUTY DIRECTOR, THE ASSISTANT DIRECTOR FOR RESEARCH, THE ASSISTANT DIRECTOR FOR EDUCATION, THE ASSISTANT DIRECTOR FOR NATIONAL AND INTERNATIONAL PROGRAMS, AND THE ASSISTANT DIRECTOR FOR RESEARCH APPLIED TO NATIONAL NEEDS.

THE FOUNDATION'S BUDGET IS DETERMINED BY CONGRESS THROUGH THE NORMAL ANNUAL APPROPRIATION PROCESS FOR FEDERAL AGENCIES. THIS YEAR, THE R & D BUDGET OF THE NSF IS APPROXIMATELY 3.3% OF THE TOTAL R & D BUDGET OF THE FEDERAL GOVERNMENT. RELATIVE TO OTHER FEDERAL AGENCIES WE ARE SMALL POTATOES. OUR BUDGET IS DIVIDED ABOUT 67% FOR BASIC RESEARCH, 19% FOR APPLIED RESEARCH, 11% FOR EDUCATION PROGRAMS AND FELLOWSHIPS, AND THE BALANCE FOR OTHER PURPOSES. VIEWED FROM ANOTHER PERSPECTIVE, IN 1974 THE NATION AS A WHOLE SPENT ABOUT $4.6 BILLION FOR BASIC RESEARCH. THE FEDERAL GOVERNMENT PROVIDED 60% OF THAT. INDUSTRY 15%, UNIVERSITIES AND COLLEGES 20%, AND OTHER SOURCES 5%. NSF PROVIDED 10%.

THESE FIGURES SHOW THAT ALTHOUGH NSF IS INFLUENTIAL IT CANNOT DOMINATE SCIENCE OR ANY PORTION OF IT. INSTEAD, WE SPREAD OUR 10% OVER ALL DISCIPLINES AND VIEW OUR ROLE AS A BALANCING OR STABILIZING INFLUENCE. OUR SUPPORT IS AN INVESTMENT IN THE FUTURE WHICH HELPS TO ASSURE THAT THE NATION DOES NOT NEGLECT AREAS OF BASIC RESEARCH WHICH SCIENTISTS CONSIDER INTERESTING AND IMPORTANT FOR THE DEVELOPMENT OF THEIR FIELD. BASIC RESEARCH INFLUENCES PROGRESS OVER A LONG TIME SPAN AND, OFTEN, IN SURPRISING WAYS. DIRAC, SCHRODINGER AND HEISENBERG DID NOT STUDY QUANTUM PHYSICS FIFTY YEARS AGO IN ORDER TO DEVELOP INTEGRATED CIRCUITS, BUT THEIR RESEARCH IS EXACTLY ON THE CRITICAL PATH TOWARD THAT GOAL. THEIR WORK WAS DONE IN

GERMAN AND ENGLISH UNIVERSITIES. NSF'S ROLE IS TO HELP ASSURE THAT SUCH WORK CONTINUES WHEREVER IT CAN IN THE U.S., EVEN THOUGH SPECIFIC, PRAGMATIC JUSTIFICATION CANNOT BE MADE AT PRESENT. WE DO IT BECAUSE WE ARE SURE THAT MOST GOOD RESEARCH WILL CONTRIBUTE SOMEWHERE, SOMETIME, TO IMPORTANT NATIONAL GOALS. SOME OF OUR WORK SEEMS REMOTE FROM APPLICATION, BUT WE HAVE FOUND, AS SCIENCE PROGRESSES AND PRIORITIES CHANGE, OTHER FEDERAL AGENCIES OR ONE OR MORE COMPANIES FROM TIME TO TIME TAKE INTEREST IN WORK WE HAVE SUPPORTED AND PUSH THE FURTHER DEVELOPMENT OF IT MUCH FASTER THAN WE COULD WITH OUR LIMITED RESOURCES. WE ARE DELIGHTED WHEN THAT HAPPENS. THAT AMPLIFYING EFFECT CONFIRMS THE HIGH LEVERAGE OF OUR PROGRAMS WHICH STRONGLY INFLUENCE PROGRESS ALTHOUGH WE CANNOT PREDICT VERY WELL, AS WE PUSH DOWN ON THE LEVER, WHAT WILL COME UP WHERE. AS ONE EXAMPLE, TWO LITTLE KNOWN NSF GRANTS WERE MADE IN 1961, TO CAL. TECH. AND MIT FOR RESEARCH ON TIME-SHARED COMPUTER SYSTEMS. TWO OR THREE YEARS LATER ARPA SAW VALUE IN TIME-SHARING FOR THE DEPARTMENT OF DEFENSE AND PUSHED IT. OTHERS FOLLOWED SOON AFTER. A NEW INDUSTRY WAS SPAWNED. WE LIKE TO THINK OUR GRANTS WERE SEMINAL AND HAD SOME PART IN THE ACT OF CONCEPTION.

JUST AS DIFFERENT PARTS OF THE FOUNDATION HAVE DIFFERENT PROGRAMS AND OBJECTIVES SO DO THEY USE DIFFERENT PRACTICES IN CONDUCTING THEIR WORK. IN BASIC RESEARCH, THE COMMON PRACTICE IS TO MAKE GRANTS OF MONEY IN RESPONSE TO UNSOLICITED PROPOSALS. IT IS AN OPEN COMPETITION IN WHICH EACH RESEARCH PROPOSAL IS JUDGED BY SCIENTISTS WHO ARE COMPETENT IN THE FIELD OF THE PROPOSAL AND CAN ASSESS ITS MERITS AND LIKELIHOOD OF SUCCESS. WE DRAW REVIEWERS FROM UNIVERSITIES, INDUSTRY AND THE NON-PROFIT ORGANIZATIONS. MANY OF YOU HAVE HELPED US MAKE SUCH ASSESSMENTS FROM TIME TO TIME. BY LAW, THE NSF CANNOT PROVIDE THE FULL COST OF THE WORK SUPPORTED BY BASIC RESEARCH GRANTS BUT MUST REQUIRE MORE THAN TOKEN COST-SHARING BY THE GRANTEE. MOST

SUCH GRANTS ARE MADE TO ACADEMIC INSTITUTIONS, SOME ARE MADE TO NOT-PROFIT ORGANIZATIONS, AND VERY FEW TO FOR-PROFITS. WE ARE ABLE TO SUPPORT ABOUT ONE-HALF OF THE PROPOSALS WE RECEIVE AND MUST OFTEN DECLINE DESERVING APPLICANTS. THOSE WE SUPPORT USUALLY RECEIVE LESS THAN THEY REQUEST. IN 1974, THE NSF MADE MORE THAN 11,400 AWARDS, NOT INCLUDING FELLOWSHIPS.

IN ITS EDUCATIONAL AND APPLIED RESEARCH PROGRAMS, THE FOUNDATION MAY AND SOMETIMES DOES SOLICIT PROPOSALS FOR SPECIFIC PURPOSES. IN THIS CASE THE AWARD INSTRUMENT MAY BE EITHER A GRANT OR A CONTRACT AND DOES NOT NORMALLY REQUIRE COST SHARING BY THE AWARDEE.

PRE-DOCTORAL AND POST-DOCTORAL FELLOWSHIPS ARE AWARDED AS A RESULT OF NATIONAL COMPETITIONS.

COMPUTING PERMEATES THE NSF AS IT DOES MOST SECTORS OF OUR NATIONAL LIFE. THERE ARE NOW FEW SCIENTISTS WHO HAVE NOT HAD SOME DIRECT ENCOUNTER WITH COMPUTING IN THEIR PROFESSIONAL EXPERIENCE, MANY HAVE BECOME MORE OR LESS SKILLED APPLICATIONS PROGRAMMERS, AND SOME HAVE DESIGNED AND BUILT SPECIAL SYSTEMS FOR EXPERIMENTAL OR EDUCATIONAL PURPOSES. THE FOUNDATION REFLECTS THESE CONCERNS IN ITS GRANTS BY PROVIDING FUNDS FOR COMPUTER TIME, COMPUTER EQUIPMENT, AND PROFESSIONAL ASSISTANCE WHEN NEEDED AND BY SUPPORTING THE DEVELOPMENT OF NEW RESEARCH OR EDUCATIONAL METHODOLOGY WHICH IS BASED UPON COMPUTERS. I AM SURE EVERY PROGRAM WHITHIN NSF IS CONCERNED TO SOME DEGREE WITH COMPUTING. UNFORTUNATELY, MOST PEOPLE'S AND MOST SCIENTIST'S PERCEPTION OF COMPUTING AND COMPUTER SCIENCE IS OF A USEFUL ALTHOUGH EXACTING AND EXPENSIVE TECHNOLOGY. THE FOUNDATION, HOWEVER, HAS ONE UNIT, THE DIVISION OF COMPUTER RESEARCH, WHICH HAS A DIFFERENT VIEW. WE PERCEIVE COMPUTER SCIENCE TO BE ALSO A NEW INTELLECTUAL FORCE WITH INNER LOGIC OF ITS OWN, DIFFERENT IN SUBSTANCE AND QUALITY FROM ANY DISCIPLINE WHICH HAS PRECEEDED IT. WE ARE CONVINCED THAT THIS FORCE WILL GRADUALLY COALESCE

THE MANY DISPARATE AND SOMETIMES CONTENDING GOALS WHICH NOW ENGAGE COMPUTER SCIENTISTS AND WILL SYNTHESIZE THEM INTO A SET OF PARADIGMS THAT PROVIDE NEW INSIGHT INTO OUR UNIVERSE AND, MORE PRAGMATICALLY, NEW TOOLS OF USE TO OURSELVES AND OUR SOCIETY. FOR THIS REASON WE HAVE SEVERAL PROGRAMS SUPPORTING BASIC RESEARCH, OR THE DEVELOPMENT OF NEW COMPUTER BASED RESEARCH METHODS, AND EXPLORING TECHNICAL PROBLEMS BROUGHT OUT BY THE INTERACTION OF COMPUTERS WITH SOCIETY. THREE PROGRAMS, THEORETICAL COMPUTER SCIENCE, SOFTWARE AND PROGRAMMING SYSTEMS, AND COMPUTER SYSTEMS DESIGN - SUPPORT BASIC RESEARCH IN AREAS OF COMPUTER SCIENCE. THEY OPERATE UNDER THE PREMISE THAT QUESTIONS WHICH ARE OF INTRINSIC INTEREST TO COMPUTER SCIENTISTS ARE WORTH INVESTIGATION FOR THEIR OWN SAKE AND WE HOLD THE FAITH THAT THESE INVESTIGATIONS WILL PROVE, WITH TIME, TO HAVE MORE THAN ENOUGH MEANING FOR OTHER DISCIPLINES AND FOR SOCIETY TO JUSTIFY THE EFFORT.

THIS IS A RELATIVELY NEW ACTIVITY FOR NSF. OUR BUDGET THIS YEAR FOR THIS PURPOSE IS $6.5 MILLION WHICH WILL SUPPORT ABOUT 90 RESEARCH PROJECTS. IN ADDITION, THE DIVISION SUPPORTS RESEARCH IN COMPUTER SCIENCE THROUGH OTHER PROGRAMS THAT ARE ADDRESSED TOWARD ALREADY DEFINED NEEDS OF OTHER DISCIPLINES OR OF THE NATION AS A WHOLE. ONE OF THESE IS OUR SOFTWARE QUALITY RESEARCH PROGRAM WHICH SUPPORTS WORK ON CRITERIA FOR MEASURING AND METHODS OF TESTING THE QUALITY OF SOFTWARE, AND ON ALGORITHMS AND PROCEDURES FOR PRODUCING SOFTWARE OF KNOWN, HIGH QUALITY. ANOTHER IS THE WORK ON THE IMPACT OF COMPUTERS ON SOCIETY WHICH IS SUPPORTING RESEARCH ON TOPICS RELEVANT TO SOCIAL OR LEGISLATIVE ISSUES ARISING FROM THE EMERGING COMPUTER TECHNOLOGY, E.G., TECHNICAL PROBLEMS IN THE AREAS OF PRIVACY OR SECURITY OF INFORMATION. DONN PARKER'S REPORT ON COMPUTER FRAUD, FOR EXAMPLE, WAS PARTIALLY SUPPORTED BY US, TO HELP ILLUMINATE THE VULNER-

ABILITY OF COMPUTER SYSTEMS. STILL OTHERS INCLUDE OUR COMPUTER TECHNIQUES AND SYSTEMS PROGRAM AND OUR NETWORKING FOR SCIENCE PROGRAMS FOR INVESTIGATING NEW, COMPUTER BASED RESEARCH METHODOLOGY IN ALL OF THE SCIENCES AND FOR EXPLORING ORGANIZATIONAL, MANAGERIAL, ECONOMIC AND OTHER USER ISSUES INVOLVED IN COMPUTER NETWORKS. FINALLY, OUR DIVISION PROVIDES LIMITED TRAVEL SUPPORT TO A FEW SCIENTISTS EACH YEAR TO HELP THEM PARTICIPATE IN INTERNATIONAL PROFESSIONAL MEETINGS HELD IN FOREIGN COUNTRIES.

THE DIVISION OF COMPUTER RESEARCH HAS A SMALL ADVISORY PANEL DRAWN FROM THE UNVIERSITIES, INDUSTRY, AND NON-PROFIT ORGANIZATIONS TO ASSIST IN FORMULATING POLICY FOR THE SUPPORT OF RESEARCH. THIS PANEL MEETS ONCE OR TWICE A YEAR, AS TRAVEL BUDGETS WILL ALLOW, TO DISCUSS PRIORITIES AND TRENDS IN RESEARCH AND SUGGEST ACTIONS WHICH NSF SHOULD CONSIDER. ONE SUCH SUGGESTION MADE TWO YEARS AGO, WHICH MAY BE OF INTEREST, WAS THAT NSF BREAK OUT COMPUTER SCIENCE SEPARATELY FROM THE OTHER NATURAL SCIENCES AND ENGINEERING IN COMPILING STATISTICS ON RESEARCH AND EDUCATION. THIS IS NOW BEING DONE. TWO NSF REPORTS I HAVE SEEN THIS YEAR, ONE ON RESEARCH EXPENDITURES AT EDUCATIONAL INSTITUTIONS AND ONE ON NUMBERS OF FACULTY, OTHER PROFESSIONALS, AND GRADUATE STUDENTS EMPLOYED AT EDUCATIONAL INSTITUTIONS HAVE COMPUTER SCIENCE SEPARATED FROM THE MATHEMATICAL SCIENCES AS A DISTINCT LINE. WE HOPE THIS WILL HELP ALL OF US KEEP TRACK OF OUR RAPIDLY GROWING FIELD BETTER.

THERE ARE TWO OTHER PROGRAM ACTIVITIES OF THE NSF, WHICH RELATE CLOSELY TO COMPUTER SCIENCE. ONE IS THE TECHNOLOGICAL INNOVATION IN EDUCATION GROUP. THROUGH THIS GROUP SUPPORT IS PROVIDED FOR NEW TECHNICAL DEVELOPMENTS OF USE TO EDUCATION AND FOR THE TESTING OF THESE IN A TEACHING ENVIRONMENT. WORK

IN COMPUTER ASSISTED INSTRUCTION, DEVELOPING COMPUTER SIMULATIONS FOR CLASSROOM USE, AND OTHER PROJECTS IN THE APPLICATION OF COMPUTERS TO EDUCATION ARE SUPPORTED THROUGH THAT GROUP.

THE OTHER IS OUR OFFICE OF SCIENCE INFORMATION SERVICES WHICH HAS HELPED ESTABLISH COMPUTER BASED INFORMATION SYSTEMS OF INTEREST TO SCIENCE. AS PART OF THEIR ACTIVITY THEY SUPPORT RESEARCH IN DATA AND TEXT STORAGE, RETRIEVAL AND PROCESSING SYSTEMS.

IN CLOSING, LET ME MENTION ONE OTHER ACTIVITY WHICH HAS BEGUN WITH NSF SPONSORSHIP. THIS IS A COMPREHENSIVE STUDY OF THE SUBSTANCE AND NATURE OF RESEARCH IN COMPUTER SCIENCE AND ENGINEERING WITH THE HOPE OF PREPARING A REPORT WHICH WILL HELP DESCRIBE TO INFORMED LAYMEN AND MEMBERS OF OUR PROFESSION WHAT COMPUTER SCIENTISTS DO AND WHY THEY ARE EXCITED AND INTELLECTUALLY CHALLENGED BY IT. THIS STUDY IS BEING DIRECTED BY PROFESSOR BRUCE ARDEN OF PRINCETON UNIVERSITY WITH THE HELP OF A STEERING COMMITTEE OF 14 PEOPLE AND 11 PANELS ON SUB-AREAS OF THE FIELD. THE TIME SCALE PROJECTED FOR COMPLETION OF THE REPORT IS ABOUT THREE YEARS. IT IS AN ATTEMPT TO SURVEY THE FIELD, DISCERN UNIFYING THREADS WHERE THEY EXIST, AND DESCRIBE THE WHOLE IN A STYLE WHICH IS FREE OF THE DETAILED MINUTIAE OF TECHNICAL LITERATURE YET SERIOUS AND INFORMATIVE. ONE THING WHICH I BELIEVE WOULD HELP OUR PROFESSION WOULD BE MORE ARTICLES IN WIDELY READ JOURNALS OR MAGAZINES WHICH SERIOUSLY ADDRESS AN INTERSTING ASPECT OF OUR DISCIPLINE OR ITS HISTORY WITHOUT LAPSING INTO GEE-WHIZ PREDICTIONS OR REPORTING. THAT WOULD HELP ESTABLISH COMPUTING'S IMAGE AS A SCIENCE IN ADDITION TO ITS ALREADY WELL ENTRENCHED IMAGE AS A SHOEWHAT AWESOME TECHNOLOGY.